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ANALYZING THE EFFECTIVENESS OF U.S . ARMS TRANSFER RESTRAINT ---ETC(U)
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ANALYZING THE EFFECTIVENESS OF U. S. ARMS TRANSFER RESTRAINT - A STATISTICAL APPROACH

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FINAL REPORT

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Editorial Review by Maj Don Ahern
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This research report is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the author.

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M. D. Bacon

M. D. BACON, Colonel, USAF
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In his May 19, 1977 Statement on Conventional Arms Transfer Policy, President Carter outlined a set of controls designed to implement his policy of arms transfer restraint. The Defense Security Assistance Agency subsequently stated that the primary purpose of these controls is to restrain the flow of advanced weapons to less-developed-country (LDC) recipients. The effectiveness of this U.S. initiative in actually dampening the flow of arms to LDCs also depends on (1) restraint on the part of West European and Warsaw Pact major arms suppliers, and/or (2) restraint on the part of LDC arms recipients. (Cont'd on reverse)

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However, any curbs on the flow of arms whether due to one or a combination of the above factors must eventually manifest itself in a decline in the pattern of LDC arms imports. This single fact provides a basis upon which the effectiveness of U.S. efforts to restrain the flow of arms to LDCs might be analyzed. Specifically this paper demonstrates one way in which statistical techniques might be used to analyze the effectiveness of President Carter's conventional arms transfer policy.

The procedure used in the analysis is to:

1. Formulate appropriate null and alternative hypotheses regarding future LDC arms imports.

2. Use regression and correlation analyses to define a quantitative relationship between LDC arms imports and the major variable(s) influencing these imports.

3. Calculate the critical value for LDC arms imports for a given year and at a specified level of confidence.

4. Test the hypotheses as data on the actual value of LDC arms imports for the given year becomes available.

I call upon suppliers and recipients alike to join us in a determined effort to make the world a safer place in which to live.[1]

President Carter
February 1, 1978

In his May 19, 1977 Statement on Conventional Arms Transfer Policy, President Carter outlined a set of controls designed to implement his policy of arms transfer restraint.[2] The Defense Security Assistance Agency subsequently stated that the primary purpose of these controls is to restrain the flow of advanced weapons to less developed country (LDC) recipients.[3] The effectiveness of this U.S. initiative to dampen the flow of arms to LDCs depends on (1) restraint by West European and Warsaw Pact major arms suppliers, and/or (2) restraint by LDC arms recipients. However, any curbs on the flow of arms must manifest itself in a decline in the pattern of LDC arms imports. This change in pattern provides a basis for analyzing the effectiveness of U.S. efforts to restrain the flow of arms to LDCs. This paper will demonstrate one way in which elementary statistical techniques might be used to analyze the effectiveness of President Carter's conventional arms transfer policy.

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[1] U.S., Congress, House, Committee on International Relations, United States Arms Transfer and Security Assistance Programs, prepared for the Subcommittee on Europe and the Middle East, 95th Cong., 2nd Sess., by the Foreign Affairs and National Defense Division, Congressional Research Service, Library of Congress, (Washington, D.C.: U.S. Government Printing Office, 1978), p. 175.

[2] U.S., Congress, Senate, Committee on Foreign Relations, Arms Transfer Policy, 95th Cong., 1st Sess., 1960, p. 1.

[3] U.S. Department of Defense, Defense Security Assistance Agency, Congressional Presentation: Security Assistance Programs FY 1980 (Washington, D.C.: Data Management Division, Comptroller, DSAA, 1979), p. 445.

Assumptions and Caveats

Both internal threats faced by LDCs as a group and LDC abilities to produce their own conventional weapons are assumed to be relatively constant throughout the time frame of this analysis. In addition, this paper is limited to an analysis of what are primarily regarded as economic variables despite the fact that political considerations undoubtedly play a major role in any decision regarding the import of weapons. This limitation is primarily due to the lack of relevant political data and the difficulties of attempting to incorporate such data into a mathematical model.

Although extrapolation beyond the range of observations (1970 through 1977) with probabilistic interpretations of inferences may be statistically questionable, this is a defensible procedure since actual extrapolations were made only one year (1978) beyond the data base. Finally, as actual data from 1978 on become available they should be incorporated into the analysis.

Methodology

The statistical techniques employed in this analysis can be found in any basic statistics textbook.[4] Briefly, the procedure is to:

1. Formulate appropriate null and alternative hypotheses regarding future LDC arms imports.
2. Use regression and correlation analyses to define a quantitative relationship between LDC arms imports and the major variable(s) influencing these imports.
3. Calculate the critical value for LDC arms imports for a given year and at a specified level of confidence.
4. Test the hypotheses as data become available on the actual value of LDC arms imports for the given year.

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[4] Lawrence L. Lapin, Statistics for Modern Business Decisions (New York: Harcourt Brace Jovanovich, Inc., 1973), provides particularly useful insights for analysis.

Hypotheses

Broadly stated, the question this paper focuses on is has U. S. restraint in the transfer of arms to LDCs since President Carter's 1977 arms transfer policy statement been effective in limiting arms imports by LDCs? Again, United States success in motivating restraint on the part of non-U.S. arms suppliers is implicit in this question. If this were not the case, then LDCs would merely substitute non-U.S. arms for those which the United States declined to sell them, and the pattern of LDC arms imports would undergo little change in the post-1977 period.

Statistically, the effectiveness states for U.S. arms transfer policy may be put simply in the form of two possible hypotheses:

1. U. S. arms restraint efforts have been ineffective.
2. U. S. arms restraint efforts have been effective.

The first hypothesis is referred to as the null hypothesis (where "null" represents no change in the natural variation of LDC arms imports). The second hypothesis is referred to as the alternative hypothesis. If we let "H_0" stand for the null hypothesis and "H_1" for the alternative hypothesis, a decision rule incorporating these hypotheses may be expressed as:

1. Accept H_0 if ACTUAL LDC arms imports are greater than a specified CRITICAL VALUE.
2. Reject H_0 (accept H_1) if ACTUAL LDC arms imports are less than a specified CRITICAL VALUE.

The specified critical value of arms imports can be calculated after a quantitative relationship between LDC arms imports and the major variable(s) influencing these imports have been defined. Regression and correlation analyses provide useful means for defining this relationship.

Regression and Correlation Analyses

Regression and correlation analyses were conducted using data[5] on LDC arms imports as the dependent variable, and gross national product (GNP), military expenditures, trade balance, and numbers of armed forces personnel as independent variable candidates. GNP is a logical variable because international trade theory indicates that a country's ability to import any product is usually a function of that country's income or output. The amount of arms which can be imported would seem also to be a function of the expenditures made by a country's armed forces. Trade balance is important because the ability of a country to import products is dependent to some degree on its foreign exchange earnings. Finally, one would expect, a priori, that a country's weapons requirements are to a certain extent dependent on the number of personnel in its armed forces.

Regressions were run in both current and constant prices, and the potential independent variables singly and in pairs were lagged 0, 1, 2, and 3 years. Military expenditures lagged two years was ultimately selected as the independent variable because of its significantly higher coefficient of determination and also because of multicollinearity considerations.

The resulting arms import function took the following form:

$$\text{ESTIMATE } I_t = -.965 + \underset{(.0247)}{.176M_{t-2}} \qquad (1)$$

[5] U.S., Department of State, Arms Control and Disarmament Agency, World Military Expenditures and Arms Transfers 1968-1977. Publication 100, October 1979, pp. 113, 27, and 70.

where ESTIMATE I_t = estimated value of LDC arms imports in year t measured in billions of current dollars;

M_{t-2} = actual value of LDC military expenditures in year t-2 measured in billions of current dollars.

The adjusted coefficient of determination, $R^2 = .876$, indicates that M_{t-2} explains a large portion of the variation in I_t. The standard error of the coefficient of M_{t-2} was equal to .0247. The F-statistic, $F_{1,6} = 50.609$ exceeds the critical F-value at the .01 significance level. The student t ratio of 7.114 for M_{t-2} shows that it is significant at the .0005 level. Both tests point out, therefore, that regression equation (1) does indeed provide a significant explanation of the variation in LDC arms imports. Figure 1, page 6, shows how closely the arms import function fits the observed data of Table 1, page 7.

The arms import function says that each $1 billion increase in military expenditures results in a $176 million increase in arms deliveries[6] two years later.

Dummy Variable

As can be seen in Figure 1, an abnormally large amount of arms were imported by LDCs in 1973, caused by a doubling of arms imports by countries in the Middle East[7] in the wake of the 1973 Arab-Israeli War.

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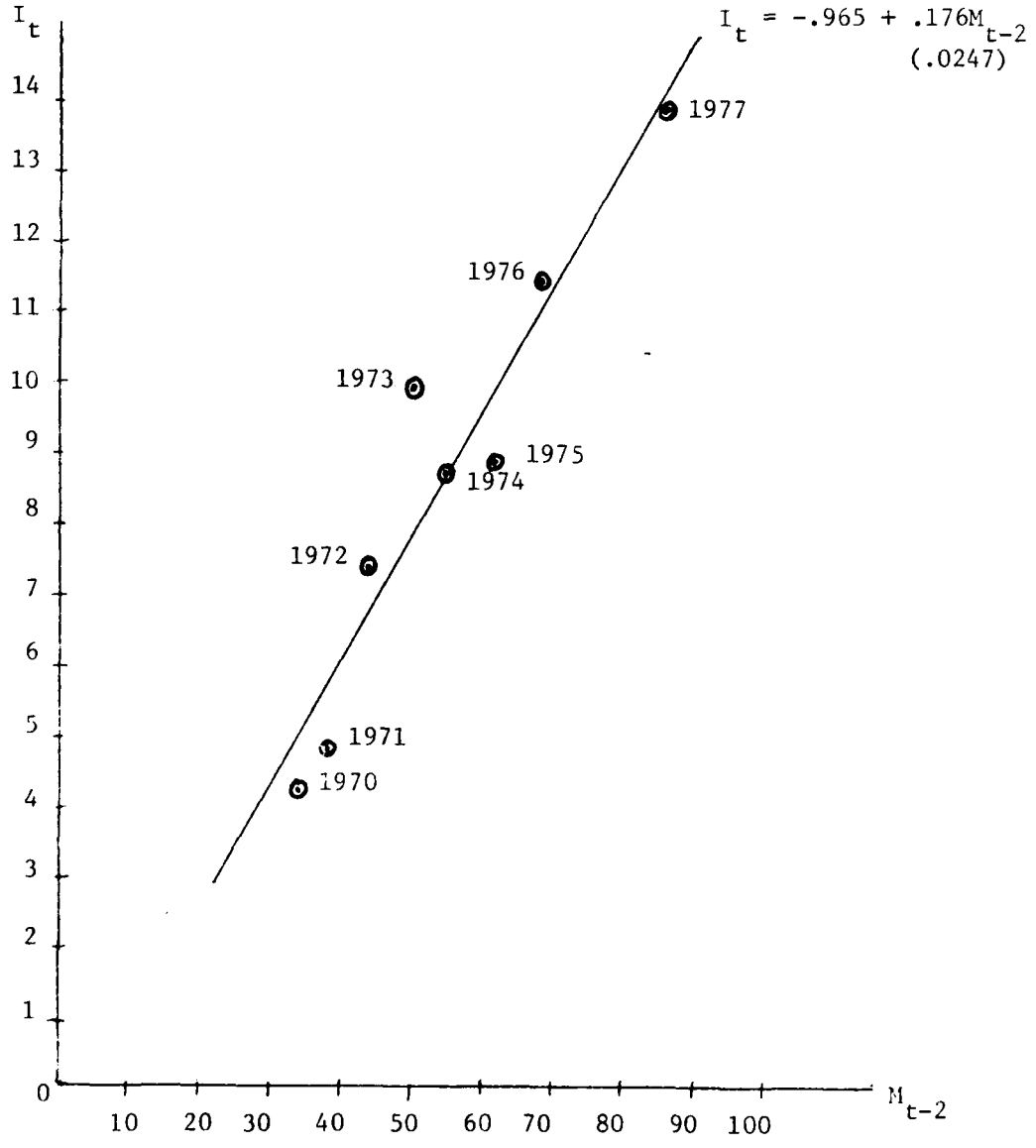
[6] Ibid., p. 23, states that arms imports data refer to: ". . . the value of goods actually delivered during the reference year, in contrast to the value of programs, contracts, or orders which may result in a future transfer of goods, or to the actual payments made for such deliveries."

[7] Ibid., p. 115.

FIGURE 1

LDC ARMS IMPORTS (I_t) VERSUS MILITARY EXPENDITURES (M_{t-2})
(Current Dollars in Billions)



DATA SOURCE: World Military Expenditures and Arms Transfers 1968-1977, U.S. ACDA, Table III, p. 113, and Table 1, p. 27.

TABLE 1

LDC ARMS IMPORTS AND MILITARY EXPENDITURES
(Current Dollars in Billions)

Year	Arms Imports (I_t)	Military Expenditures (M_{t-2})
1970	4.145	33.3
1971	4.715	37.5
1972	7.320	43.6
1973	9.805	49.3
1974	8.600	54.2
1975	8.725	61.1
1976	11.355	68.0
1977	13.680	85.4
1978	-	92.8

SOURCE: World Military Expenditures and Arms Transfers 1968-1977, U.S. ACDA, Table III, p. 113, and Table 1, p. 27.

TABLE 2

LDC ARMS IMPORTS, MILITARY EXPENDITURES,
AND DUMMY VARIABLE
(Current Dollars in Billions)

Year	Arms Imports (I_t)	Military Expenditures (M_{t-2})	Dummy Variable
1970	4.145	33.3	0
1971	4.715	37.5	0
1972	7.320	43.6	0
1973	9.805	49.3	1
1974	8.600	54.2	0
1975	8.725	61.1	0
1976	11.355	68.0	0
1977	13.680	85.4	0
1978	-	92.8	-

SOURCE: World Military Expenditures and Arms Transfers 1968-1977, U.S. ACDA, Table III, p. 113, and Table 1, p. 27.

A dummy variable was incorporated into the model to take into account the difference in arms imports which would occur during a war as opposed to what would occur during peacetime. The dummy variable "D" took on the value of "0" during peacetime and "1" during the 1973 war as in Table 2, page 7. The arms import function then became:

$$\text{ESTIMATE } I_t = -1.570 + \underset{(.0156)}{.181M_{t-2}} + \underset{(.757)}{2.427D} \qquad (2)$$

The adjusted coefficient of determination, R^2, increased from .876 to .951, and the standard error of the coefficient of M_{t-2} decreased from .0247 to .0156. The student t-ratio of 11.637 for M_{t-2} shows that it is still significant at the .0005 level. The student t-ratio of 3.205 for the dummy variable, D, indicates that it is significant at about the .02 level. The F-statistic, $F_{2,5} = 69.544$, exceeds the critical F-value at the .01 significance level. In addition, the F-test which measures the significance of adding D to equation (1) in arriving at equation (2) is:

$$F_{1,5} = \frac{R^2_{(2)} - R^2_{(1)}}{1 - R^2_{(2)}} \cdot \frac{\#\text{ of data points} - \#\text{ of variables in (2)}}{\#\text{ of variables in (2)} - \#\text{ of variables in (1)}}$$

$$= \frac{.951 - .876}{1 - .951} \cdot \frac{8-3}{3-2} = 7.653$$

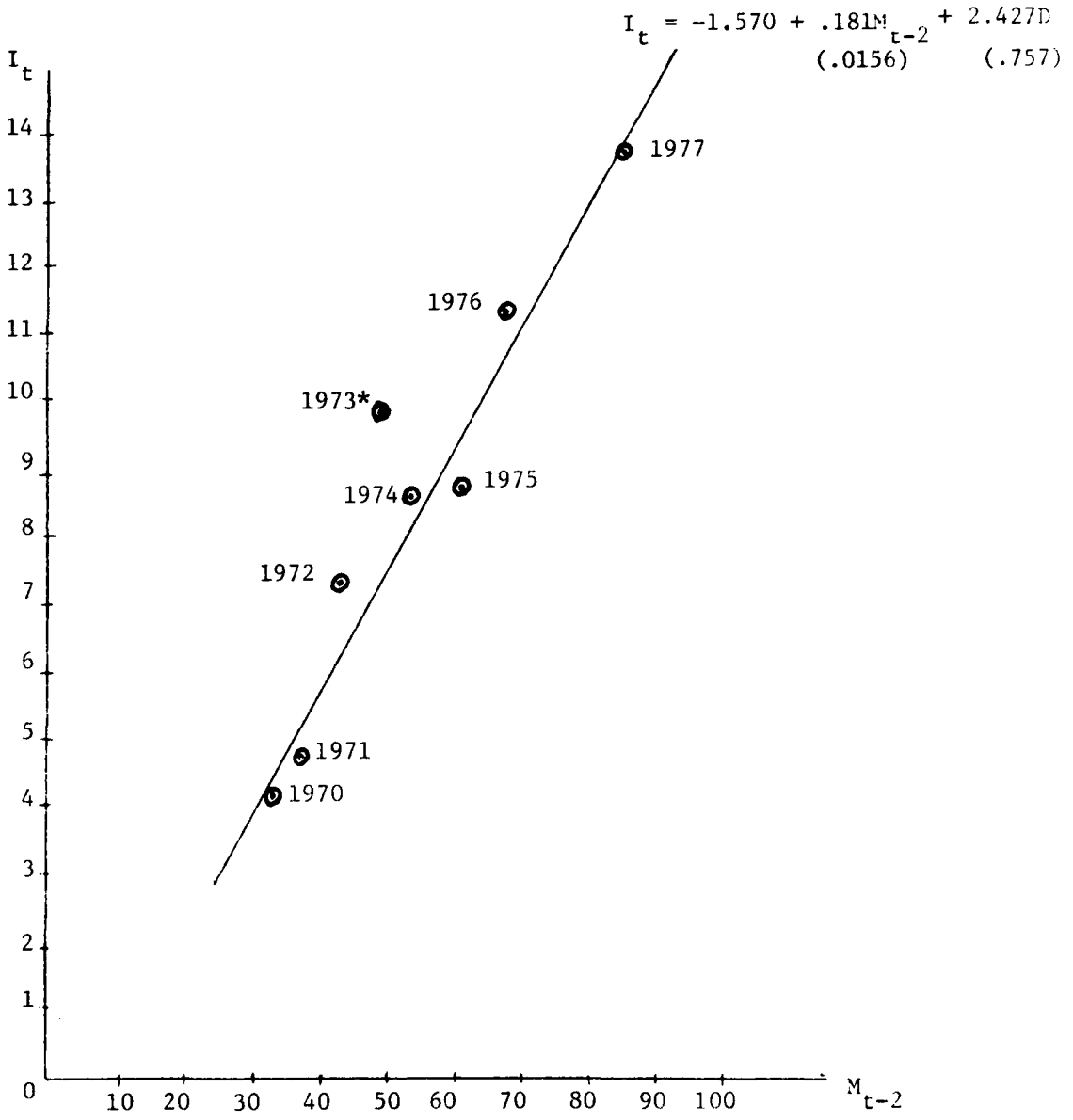
This means that addition of D was significant at the .05 level. We may conclude, therefore, that regression equation (2) provides an even better explanation of the variation in LDC arms imports than did equation (1). From this point on, our analysis will use equation (2) to estimate LDC arms imports. Figure 2, page 10, shows the revised arms import curve. The revised arms import equation indicates that of the $9.805 billion spent on arms imports by LDCs in 1973, $2.427 billion was attributable to the war, while the remainder represents what would have occurred regardless of the war.

Critical Value and Sample Calculation

The critical value of LDC arms imports (CRITICAL I_t) required by the decision rule depends not only on ESTIMATE I_t and S_u, the standard error of the residual term, but also on the level of confidence desired in commenting on the effectiveness of U. S. arms restraint efforts. The procedure used to calculate CRITICAL I_t is best illustrated by doing an actual calculation. For the small samples associated with our arms import data, the Student t distribution is an appropriate sampling distribution to use.

FIGURE 2

LDC ARMS IMPORTS (I_t) VERSUS MILITARY EXPENDITURES (M_{t-2})
(Current Dollars in Billions)



*The abnormally large 1973 arms import figure was caused by the Arab-Israeli War, and was accounted for in the equation by a dummy variable.

DATA SOURCE: World Military Expenditures and Arms Transfers 1968-1977, U.S. ACDA, Table III, p. 113, and Table I, p. 27.

CRITICAL I_t is calculated with the following equation:

$$(3)\quad \text{CRITICAL } I_t = \text{ESTIMATE } I_t \pm t_{\frac{\alpha}{2}} \cdot S_u \sqrt{\frac{1}{n} + \frac{(M_{t-2} - \bar{M})^2}{\sum_{t=1970}^{1977} M_{t-2}^2 - n\bar{M}^2}} + 1$$

From our regression analysis we know that

$$\text{ESTIMATE } I_t = -\ 1.570 + .181\ M_{t-2} + 2.427\ D \qquad (2)$$

If $I_t = I_{1978}$, then $M_{t-2} = M_{1976}$.

From Table 1, we get $M_{t-2} = M_{1976} = 92.8$

Therefore, ESTIMATE $I_{1978} = -\ 1.570 + .181\ (92.8) + 2.427\ (0) = 15.227$

The number of data points, n = 8 (for t = 1970 to 1977)

$\therefore$ degrees of freedom = n - 3 = 5

With 5 degrees of freedom, if a <u>90% confidence level</u> is desired,

$$t_{\frac{\alpha}{2}} = t_{.05} = 2.015$$

From our regression analysis, $S_u = .704$

From Table 1, $\bar{M} = \dfrac{\sum_{t=1970}^{1977} M_{t-2}}{n} = 54.02,$

and $\sum_{t=1970}^{1977} M_{t-2} = 25,434.$

Substituting in (3),

$$\text{CRITICAL } I_t = 15.227 \pm (2.015)\ (.704)\ (1.361)$$

$$= 15.227 \pm 1.931$$

$$= \underline{17.158} \text{ or } \underline{13.296}$$

Hypothesis Testing

By substituting CRITICAL I_t = \$17.158 billion and \$13.296 billion into our null and alternative hypotheses, our decision rule may be restated as follows:

-If ACTUAL I_{1978} > \$17.158 billion, we may say with 90% confidence that U.S. arms transfer policy has been ineffective in restraining arms imports by LDCs in 1978 (i.e., accept H_0).

-If ACTUAL I_{1978} < \$13.296 billion, we may say with 90% confidence that U.S. arms transfer policy has been effective in restraining arms imports by LDCs in 1978 (i.e., reject H_0, accept H_1).

As should be expected, a higher confidence level will lead to a wider range for CRITICAL I_t. For example, if a 95% confidence level is desired,

$$t_{\frac{\alpha}{2}} = t_{.025} = 2.571$$

$$\text{CRITICAL } I_{1978} = 15.227 \pm (2.571)\ (.704)\ (1.361)$$

$$= 15.227 \pm 2.463$$

$$= 17.690 \text{ or } 12.764$$

In other words, the decision rule becomes:

-If ACTUAL I_{1978} > \$17.690 billion, we may say with 95% confidence that U.S. arms transfer policy has been ineffective in restraining arms imports by LDCs in 1978 (i.e., accept H_0).

-If ACTUAL I_{1978} < \$12.764 billion, we may say with 95% confidence that U.S. arms transfer policy has been effective in restraining arms imports by LDCs in 1978 (i.e., reject H_0, accept H_1).

Conclusion

This paper has demonstrated one way in which basic statistical techniques might be used to analyze the effectiveness of President Carter's conventional arms transfer policy. In closing, I would like to mention two major areas for further exploration. First, additional insights might be derived by categorizing LDCs by country, region, or other homogeneous grouping (e.g., oil exporting versus non-oil exporting LDCs). Second, if wars in LDCs such as Afghanistan continue to occur, the model might be further refined through the use of an index of violence as an exogeneous variable.

BIBLIOGRAPHY

Lapin, Lawrence L. Statistics for Modern Business Decisions. New York: Harcourt Brace Jovanovich, Inc., 1973.

U.S. Congress. House. Committee on International Relations. United States Arms Transfer and Security Assistance Programs. Prepared for the Subcommittee on Europe and the Middle East. 95th Cong., 2d Sess., by the Foreign Affairs and National Defense Division, Congressional Research Service, Library of Congress. Washington, D.C.: Government Printing Office, 1978.

U.S. Congress. Senate. Committee on Foreign Relations. Arms Transfer Policy. Senate Report, 95th Cong., 1st Sess., 1977.

U.S. Department of Defense. Defense Security Assistance Agency. Congressional Presentation: Security Assistance Programs FY 1980. Washington, D.C.: Data Management Division, Comptroller, DSAA, 1979.

U.S. Department of State. Arms Control and Disarmament Agency. World Military Expenditures and Arms Transfers 1968-1977. Publication 100, October 1979.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